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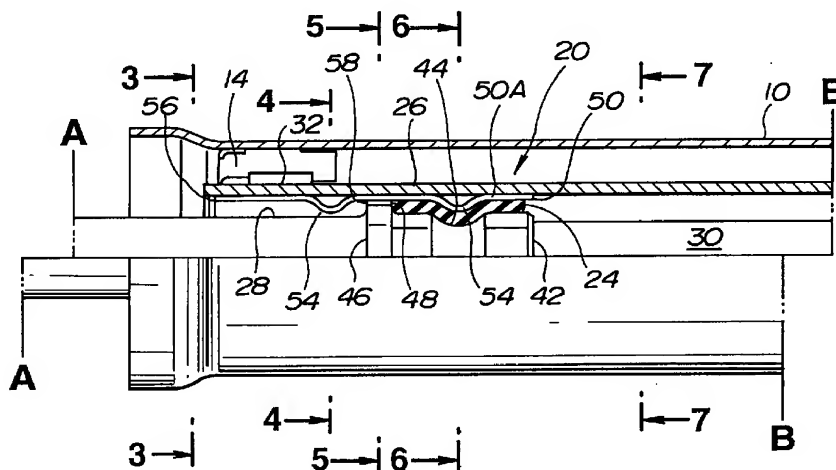
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## (54) Vehicle steering column with axially slidable coupling

(57) A vehicle steering column includes a coupling (20) between two portions (16,18) of the steering column. The coupling (20) incorporates two relatively slidable coupling parts (26,28), a sliding member (50) in contact with one of the two coupling parts (26,28) and a resilient member (24) disposed between said sliding member (50) and the other of the two coupling parts (26,28). The resilient member (24) inhibits transmission of vibration through the steering column and it is stressed or compressed to provide a resilient bias to

establish firm engagement of the sliding member (50) with the one of two coupling parts (26,28), thus resisting relative axial movement of the two portions (16,18) of the steering column toward one another. Owing to the provision of the sliding member (24), smooth telescopic movement of the two portions (16,18) of the steering column is provided when a force tending to move the two portions (16,18) of the steering column toward one another exceeds a predetermined value.

FIG.1B



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## Description

### BACKGROUND OF THE INVENTION

The present invention relates to a vehicle steering column and to a vehicle steering column including a coupling between two portions of the steering column.

A current vehicle steering system is one where two portions of the steering column move in axial direction toward one another when a force tending to move these two portions toward one another exceeds a predetermined value. In order to provide an acceptable construction, the system should have no perceptible vibration or backlash with high torque capability and a high resistance to relative axial movement of the two portions of the steering column toward one another.

Accordingly, a suitable system is provided including features more fully disclosed hereinafter.

### SUMMARY OF THE INVENTION

According to one aspect of the present invention, there is provided a vehicle steering column including a coupling between two portions of the steering column, which coupling incorporates two relatively slidable coupling parts, a sliding member in contact with one of said two coupling parts and a resilient member disposed between said sliding member and the other of said two coupling parts, said resilient member being so constructed and arranged as to inhibit transmission of vibration through the steering column and resist relative movement of the two portions of the steering column toward one another.

According to another aspect of the present invention, there is provided a vehicle steering column including a coupling between two portions of the steering column, which coupling incorporates two coupling parts, a sliding member in contact with one of said two coupling parts and a resilient member stressed between said sliding member and the other of said two coupling parts to bias said sliding member into engagement with said one of said two coupling parts.

According to still another aspect of the present invention, there is provided a coupling between two portions of a vehicle steering column, comprising two coupling parts, a sliding member in contact with one of said two coupling parts and a resilient member stressed between said sliding member and the other of said two coupling parts to bias said sliding member into engagement with said one of said two coupling parts, said sliding member and said resilient member being so constructed and arranged as to transmit torque through said coupling parts and inhibit transmission of vibration therethrough.

### BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1A, 1B, 1C and 1D, when combined at lines A-A, B-B, C-C and D-D, show a fragmentary view of a

vehicle steering system including a steering column with an upper half thereof broken to show partly a section of a coupling taken through the line 1-1 shown in Fig. 6;;

Figs. 2A, 2B and 2C, when combined at lines E-E and F-F, show a top plan view of the steering column;

Fig. 3 is a cross section taken through the line 3-3 of the steering column shown in Fig. 1B;

Fig. 4 is a cross section taken through the line 4-4 of the steering column shown in Fig. 1B;

Fig. 5 is a cross section taken through the line 5-5 of the steering column shown in Fig. 1B;

Fig. 6 is a cross section taken through the line 6-6 of the steering column shown in Fig. 1B;

Fig. 7 is a cross section taken through the line 7-7 of the steering column shown in Fig. 1B;

Fig. 8 is a fragmentary view of a vehicle steering system including a steering column with an upper half thereof broken to show an alternative coupling; Fig. 9 is a top plan view of the steering column of Fig. 8 partly broken to show the coupling;

Fig. 10 is a cross section taken through the line 10-10 in Fig. 9;

Fig. 11 is a perspective view of a two-piece type collar used in the coupling shown in Figs. 8 and 9;

Fig. 12 is a perspective view of a one-piece type collar which may be used in the coupling shown in Figs. 8 and 9;

Fig. 13 is a perspective view of a sliding member in the form of a two-piece type collar used in the coupling shown in Figs. 8 and 9;

Fig. 14 is a perspective view of a sliding member in the form of a one-piece type collar which may be used in the coupling shown in Figs. 8 and 9;

Fig. 15 is a fragmentary view of a vehicle steering column with an upper half thereof broken to show another coupling; and

Fig. 16 is a perspective view of a sliding member in the form of a two-piece type collar used the coupling shown in Fig. 15.

### DETAILED DESCRIPTION OF THE INVENTION

Referring to Figs. 1A, 1B, 1C and 1D, the steering column is rotatably carried within a jacket tube 10 at an upper mounting point 12 and a lower mounting point 14. The steering column includes an upper steering shaft 16 forming one major portion thereof and a lower steering shaft 18 forming a second major portion thereof and a coupling 20. A steering wheel, not shown, is attached to the upper steering shaft 16. A universal joint 22 is shown attached to the lower steering shaft 18.

Figs. 1B and 2A show how the coupling 20 between the steering column portions 16 and 18 incorporates a resilient member 24 in the form of a rubber socket disposed between two relatively slidable coupling parts 26 and 28 to inhibit transmission of vibration through the

steering column and to provide torque transmission therethrough.

Referring also to Figs. 3 to 7, the coupling parts are in the form of an outer tube 26 and a co-axial inner shaft 28, respectively. The outer tube 26 defines a bore 30 with a non-circular or more specifically a double-D cross section. This bore 30 slidably receives the inner shaft 28 and extends axially over a length long enough to allow a required stroke of telescopic motion of the inner shaft 28 to yield a desired impact absorbing performance of the steering column. In this embodiment, the outer tube 26 forms an integral part of the upper steering shaft 16 and the outer wall of the outer tube 26 is cylindrical at an end portion 32 to mate with bearing at the lower mounting point 14 (see Figs. 2A, 3 and 4). As readily seen from Figs. 5, 6 and 7, at a portion where the bore 30 is defined, the outer wall of the outer tube 26 includes two spaced cylindrical wall sections 34 and 36 interconnected by two laterally spaced flat wall sections 38 and 40.

The inner shaft 28, which forms an integral part of the lower steering shaft 18 in this embodiment, has a piston 42 disposed in the bore 30. The piston 42 has a non-circular or double-D cross section of a cross sectional profile similar to a cross sectional profile of the bore 30. The piston 42 is recessed at a portion intermediate two axially spaced ends thereof to define a circumferential recessed wall or groove 44 having a cross section as shown in Fig. 6. The inner shaft 28 has an integral intermediate member 46 adjacent the piston 32. The intermediate member 46 is also of a non-circular or double-D cross section and defines a shoulder 48. The intermediate member 46 is also disposed in the bore 30.

The resilient member 24 surrounds and fixed to the piston 42 in abutting relation to the shoulder 48 of the intermediate member 46. The resilient member 24 can be fixed to the piston 42 by a portion thereof press fit into the recessed wall 44 or it can be bonded to the piston 42. The thickness of the resilient member 24 around the piston 42 before the piston 42 is inserted into the bore 30 is greater than the height of a space defined between the piston 42 and the inner wall defining the bore 30 when the upper and lower steering shafts 16 and 18 are aligned.

The coupling 20 includes a sliding member 50 fitted between the resilient member 24 and the inner wall defining the bore 30. The sliding member 50 surrounds and fits about the resilient member 24 and it has a cross section matching that of the bore 30 and has a close fit in the bore 30. The sliding member 50 is in the form of a two-piece type collar dividable by an axially extending plane into two halves 50A and 50B (see Figs. 3 to 7) or it may be in the form of a one-piece type collar. The sliding member 50 extends over and around the perimeter of intermediate member 46 and has two axially spaced inward projections 52 and 54. The inward projection 52 is positioned around the recessed wall 44 of the piston 42 to flex a portion of the resilient member 24 into firm

engagement with the recessed wall 44, as best seen in Fig. 6. This arrangement provides unitary movement of the sliding member 50 with movement of the piston 42 during axial telescopic movement of the inner shaft 28 into the outer tube 26. The sliding member 50 is formed from a sheet of metal in this embodiment although it may be formed of a plastic material.

The other inward projection 54 is located on the opposite side of the intermediate member 46 to the side where the piston 42 is located. This projection 54 is arranged to abut the intermediate member 46 to prevent removal of the inner shaft 28 from the outer tube 26. Both of these inward projections 52 and 54 are formed by deforming the corresponding portions of the sliding member 50 inwardly as best seen in Figs. 6 and 4. Providing a stop against removal of the sliding member 50 from the outer tube 26, the outer tube 26 has one end projecting slightly beyond and crimped over an outer end 56 of the sliding member 50.

As shown in Figs. 1B and 5, the intermediate member 46 and the sliding member 50 define therebetween a space 58, around the circumference of the intermediate member 46, which allows an angular motion of the outer tube 26 and the inner shaft 28 relative to one another within a predetermined limited range of angles. The intermediate member 46 comes into mechanical drive contact with the sliding member 50 to prevent angular motion of the outer tube 26 and the inner shaft 28 relative to one another beyond the predetermined range of angles. The space 58 is kept open by resilient bias owing to the resilient member 24 stressed or loaded between the sliding member 50 and the piston 42. Owing to this resilient bias of the resilient member 24, the sliding member 50 is held in engagement with the inner wall defining the bore 30 in press fit manner, while the resilient member 24 is held in firm engagement with the recessed wall 44 and thus in fixed relation to the piston 42.

Transmission of torque or rotational drive through the steering column is taken through these items with the safety aspect being covered by the mechanical drive of the intermediate member 46 of the inner shaft 28 and the sliding member 50 press fitted in the bore 30, with the double-D cross section, of the outer tube 26. This safety arrangement protects the resilient member 24.

In normal use, there is no axial movement between the sliding member 50 and the outer tube 26 in slidable fashion owing mainly to firm engagement of the sliding member 50 into the inner wall defining the bore 30. This arrangement resists relative axial movement of the two portions 16 and 18 of the steering column toward one another.

When a force tending to move the two portions 16 and 18 of the steering column toward one another exceeds a predetermined value during, for example, front end collision of the vehicle, the sliding member 50 moves together with the resilient member 24 and the piston 42 of the inner shaft 28 to slide on the inner wall defining the bore 30 of the outer tube 26, thus allowing

telescopic movement of the inner shaft 28 relative to the outer tube 26.

The first embodiment described above includes the sliding member 24 fitted about the resilient member 24 which is fixed relative to the inner shaft 28 to allow slidable movement of the sliding member 50 on the outer tube 26 during telescopic axial movement of the inner shaft 28 into the outer tube 26. In the second and third embodiments described hereinafter, a sliding member is surrounded by a resilient member which is held in fixed relation with an outer tube and fits about an inner shaft to allow slidable movement of this sliding member on the inner shaft during telescopic axial movement of the inner shaft into the outer tube.

Referring to Figs. 8 to 9, the second embodiment incorporates substantially the same outer tube as the outer tube 26 used in the first embodiment. Thus, the same references as used in the first embodiment are used to denote the outer tube and the corresponding parts or portions of the outer tube for brevity of description.

As shown in Figs. 8 and 9, a steering column includes a coupling 70. The coupling incorporates a resilient member 72 in the form of a rubber socket disposed between two relatively slidable coupling parts, namely the outer tube 26 and a co-axial inner shaft 74. As different from its counterpart of the first embodiment, the inner shaft 74 does not have a portion corresponding to the piston 42 and has a uniform non-circular or more specifically double-D cross section over its entire length. The inner shaft is recessed to define recessed wall 76. The resilient member 72 is substantially the same as its counterpart in the first embodiment.

The coupling 70 includes a sliding member 78 in the form of a two-piece type inner collar as shown in Fig. 13 and a two-piece type outer collar 80 as shown in Fig. 11. The sliding member 78 is deformed inwardly at its cylindrical wall portions to define inward projections 82 which engage into the recessed walls 76, only one being shown in Fig. 8. At outer axial end, the sliding member 78 is formed with laterally extending ears 84. In assembly, the resilient member 72 fits about the sliding member 78 in abutting relation to the laterally extending ears 84, then the inner shaft 74 is inserted through the sliding member 78, and then an intermediate member 82 in the form of a cap is fixedly coupled with the inner shaft 74 at a leading end thereof (see Figs. 8 and 9). The intermediate member 86 is substantially the same in function with that of its counterpart 46 in the first embodiment. After fitting the resilient member 72 about the sliding member 78 on the inner shaft 74, the two halves of the outer collar 80 fit about the outer circumference of the resilient member 72 in a manner of interposing therebetween the resilient member 72. Providing correct positioning of the resilient member 72, each of the halves of the outer collar 80 is formed with axially spaced inward projections 88 and 90 between which the resilient member 72 is positioned. The outer collar 80 has a press fit in a bore 30 of the outer tube 26 and is

formed with portions 92 deformed radially inwardly to flex the resilient member into the inwardly deformed portions 82 of the sliding member 78. As best seen in Fig. 10, the outer tube 26 extends slightly beyond and crimped over an outer end 94 of the outer collar 80 at four portions 96. The outer end 94 of the outer collar 80 projects slightly beyond and crimped over the one end of the outer tube 26 at portions 98 (see Figs. 8 and 12). In this manner the outer collar 80 is held in fixed relation to the outer tube 26. Owing to the resilient bias of the resilient member 72 stressed or compressed between the sliding member 78 and the outer collar 80, the inward projections 88 is held in engagement with the recessed walls 76 of the inner shaft 74. In normal use of the steering column, this arrangement prevents relative axial movement between the inner shaft 74 and the outer tube 26.

If desired, the resilient member 72 may be bonded to the sliding member 78 and the outer collar 80 before assembly with the outer tube 26.

The intermediate member 86 and the inner wall defining the bore 30 of the outer tube 26 define therebetween a space which allows angular motion of the outer tube 26 and the inner shaft 74 relative to another within the predetermined limited range of angles. The intermediate member 86 comes into mechanical drive contact with the inner wall of the outer tube 26 to prevent angular motion of the outer tube 26 and the inner shaft 74 relative to one another beyond the predetermined limited range of angles.

When a force tending to move the two portions of the steering column toward one another exceeds a predetermined value, the inward projections 82 of the sliding member 78 disengages from the recessed walls 76 to allow the sliding member 78 to slide on the inner shaft 74 thereby to allow axial telescopic movement of the inner shaft 74 into the outer tube 26.

Fig. 12 shows a one-piece version of an outer collar. This modified outer collar is designated by the reference numeral 80A. Fig. 14 shows a one-piece version of inner collar serving as the sliding member. This version is denoted by the reference numeral 14A. As difference from the sliding member 74, the sliding member 78A is formed with an axial slit 104 and incorporates a flange 84A instead of laterally extending ears 84 (see Fig. 13).

As readily seen from Figs. 8 and 9, accidental removal of the inner shaft 74 from the sliding member 78 is prevented by abutting engagement of the intermediate member 86 with the outer collar 80.

Referring to Figs. 15 and 16, the third embodiment is described. This embodiment is substantially the same as the second embodiment except that a coupling 120 of the third embodiment includes an outer collar 80B which is not formed with the inwardly deformed portions 92 of the outer collar 80 used in the second embodiment and a sliding member 122 as illustrated in Fig. 16 with a resilient member 72 stressed or compressed between the outer collar 80B and the sliding member 122. In the second embodiment, the resilient member 72 surrounds

the outer circumference of the sliding member 78 (see Fig. 13) entirely from one to the opposite axial ends of the sliding member 78. As different from the second embodiment, the resilient member 72 does not cover or surround inwardly deformed portions 82A of the sliding member 122. In other words, recessed walls 76A of an inner shaft 74 and the inwardly deformed portions 82A in engagement with the recessed walls 76A are axially offset from the resilient member 72. Another difference from the second embodiment is that the sliding member 122 is held in fixed relation with an outer tube 26 by means of laterally projecting ears 124 extending over the end of the outer tube 26.

When a force tending to move the two portions of the steering column toward one another exceeds a predetermined value, the inward projections 82A of the sliding member 122 disengages from the recessed walls 76A to allow the sliding member 78 to slide on the inner shaft 74 thereby to allow axial telescopic movement of the inner shaft 74 into the outer tube 26. According to this third embodiment, the resilient member 72 has little influence on engagement of the inwardly deformed portions 82A into the recessed walls 76A. Thus, the property of the sliding member 122 determines a force required from the inwardly deformed portions 82A to escape from the recessed walls 76A upon initiation of the telescopic movement of the inner shaft 74 into the outer tube 26.

From the preceding description it will now be appreciated that, with a simple and easy-to-assemble construction, transmission of vibration through the steering column is inhibited and relative axial movement of the two portions of the steering column is resisted.

## Claims

1. A vehicle steering column including a coupling between two portions of the steering column, which coupling incorporates two relatively slidable coupling parts, a sliding member in contact with one of said two coupling parts and a resilient member disposed between said sliding member and the other of said two coupling parts, said resilient member being so constructed and arranged as to inhibit transmission of vibration through the steering column and resist relative movement of the two portions of the steering column toward one another.
2. A vehicle steering column as claimed in claim 1, wherein said resilient member allows the relative movement of the two portions of the steering column toward each other when a force tending to move the two portions of the steering column toward one another exceeds a predetermined value.
3. A vehicle steering column as claimed in claim 1, wherein said two coupling parts are in the form of an outer tube defining a bore with a non-circular cross section and a co-axial inner shaft, respectively, said inner shaft being slidably arranged in said bore of said outer tube.
4. A vehicle steering column as claimed in claim 3, wherein said resilient member is disposed around said inner shaft and said outer tube is disposed around said resilient member.
5. A vehicle steering column as claimed in claim 4, wherein said sliding member fits in said bore of said outer tube and about said resilient member and said resilient member is fixed to said inner shaft and stressed between said sliding member and said inner shaft to bias said sliding member into engagement with said outer tube.
6. A vehicle steering column as claimed in claim 5, wherein said inner shaft has a piston disposed in said bore, said piston having a non-circular cross section of a cross sectional profile similar to a cross sectional profile of said non-circular cross section of said bore of said outer tube.
7. A vehicle steering column as claimed in claim 6, wherein said piston is formed with recess means.
8. A vehicle steering column as claimed in claim 7, wherein said inner shaft has an intermediate member adjacent said piston and disposed in said bore, and said intermediate member defines a shoulder.
9. A vehicle steering column as claimed in claim 8, wherein said resilient member surrounds said piston and said sliding member has a portion deformed inwardly toward said piston to flex said resilient member into said recess means.
10. A vehicle steering column as claimed in claim 9, wherein said resilient member is interposed between said sliding member and said piston in abutting relation to said shoulder of said intermediate member.
11. A vehicle steering column as claimed in claim 10, wherein said sliding member extends over and around said intermediate member.
12. A vehicle steering column as claimed in claim 11, wherein said intermediate member and said sliding member define therebetween a space, around said intermediate member, which allows angular motion of said outer tube and said inner shaft relative to one another within a predetermined limited range of angles.
13. A vehicle steering column as claimed in claim 12, wherein said intermediate member comes into mechanical contact with said sliding member to

prevent angular motion of said outer tube and said inner shaft relative to one another beyond said predetermined limited range of angles.

14. A vehicle steering column as claimed in claim 13, wherein said sliding member has an inner end adjacent said piston and an outer end, and said outer tube has one end projecting beyond and crimped over said outer end of said sliding member. 5
15. A vehicle steering column as claimed in claim 14, wherein said sliding member glides on said outer tube to allow movement of said inner shaft relative to said outer tube when a force tending to move the two portions of the steering column toward one another exceeds a predetermined value. 10
16. A vehicle steering column as claimed in claim 4, wherein said sliding member fits about said inner shaft and said resilient member is disposed in said bore of said outer tube and surrounds said sliding member, and wherein said resilient member stressed between said sliding member and said outer tube to bias said sliding member into engagement with said inner shaft. 15
17. A vehicle steering column as claimed in claim 5, wherein said inner shaft has a non-circular cross section of a cross sectional profile similar to a cross sectional profile of said non-circular cross section of said bore of said outer tube. 20
18. A vehicle steering column as claimed in claim 17, wherein said inner shaft is formed with recess means. 25
19. A vehicle steering column as claimed in claim 18, wherein said inner shaft has an intermediate member at one end thereof. 30
20. A vehicle steering column as claimed in claim 18, wherein said sliding member has a portion deformed inwardly into engagement with said recess means. 35
21. A vehicle steering column as claimed in claim 20, wherein said coupling includes a collar fitting in said bore of said outer tube, held in fixed relation to said outer tube and surrounding said resilient member, and wherein said collar has a portion deformed inwardly toward said inner shaft to flex said resilient member into said inwardly deformed portion of said sliding member. 40
22. A vehicle steering column as claimed in claim 21, wherein said collar has an outer axial end and an inner axial end positioned inwardly into said bore of said outer tube further than said outer axial end thereof, and said outer axial end of said collar 45

projects beyond and crimped over one end of said outer tube.

23. A vehicle steering column as claimed in claim 22, wherein said inwardly deformed portion of said sliding member disengages from said recess means to allow movement of said inner shaft relative to said outer tube when a force tending to move the two portions of the steering column toward one another exceeds a predetermined value. 50
24. A vehicle steering column as claimed in claim 19, wherein said intermediate member and said outer tube define therebetween a space which allows angular motion of said outer tube and said inner shaft relative to one another within a predetermined limited range of angles. 55
25. A vehicle steering column as claimed in claim 24, wherein said intermediate member comes into mechanical contact with said outer tube to prevent angular motion of said outer tube and said inner shaft relative to one another beyond said predetermined limited range of angles.
26. A vehicle steering column as claimed in claim 20, wherein said coupling includes a collar fitting in said bore of said outer tube, held in fixed relation to said outer tube and surrounding said resilient member, and said sliding member is anchored to said outer tube.
27. A vehicle steering column as claimed in claim 26, wherein said recess means of said inner shaft and said inwardly deformed portion of said sliding member are axially offset from said resilient member.
28. A vehicle steering column as claimed in claim 27, wherein said inwardly deformed portion of said sliding member disengages from said recess means to allow movement of said inner shaft relative to said outer tube when a force tending to move the two portions of the steering column toward one another exceeds a predetermined value.
29. A vehicle steering column including a coupling between two portions of the steering column, which coupling incorporates two coupling parts, a sliding member in contact with one of said two coupling parts and a resilient member stressed between said sliding member and the other of said two coupling parts to bias said sliding member into engagement with said one of said two coupling parts.
30. A vehicle steering column as claimed in claim 29, wherein said resilient member is held in fixed relation with the other of said two coupling parts.

31. A coupling between two portions of a vehicle steering column, comprising two coupling parts, a sliding member in contact with one of said two coupling parts and a resilient member stressed between said sliding member and the other of said two coupling parts to bias said sliding member into engagement with said one of said two coupling parts, said sliding member and said resilient member being so constructed and arranged as to transmit torque through said coupling parts and inhibit transmission of vibration therethrough.

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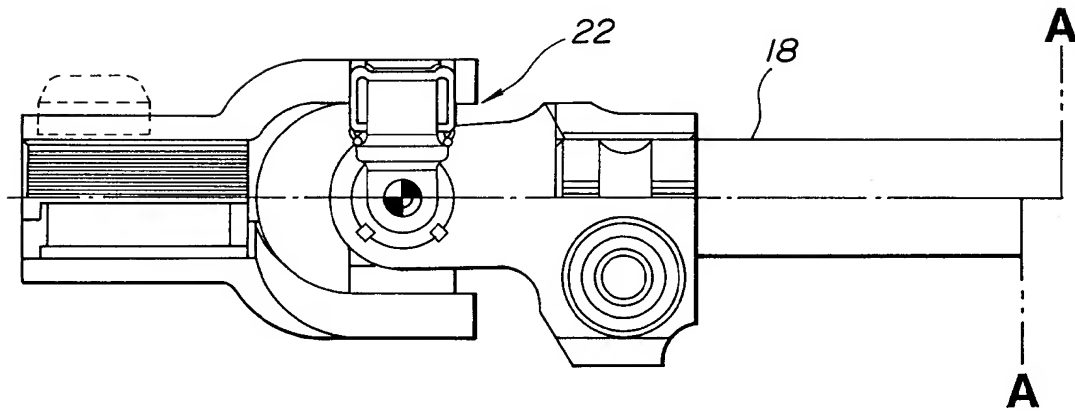
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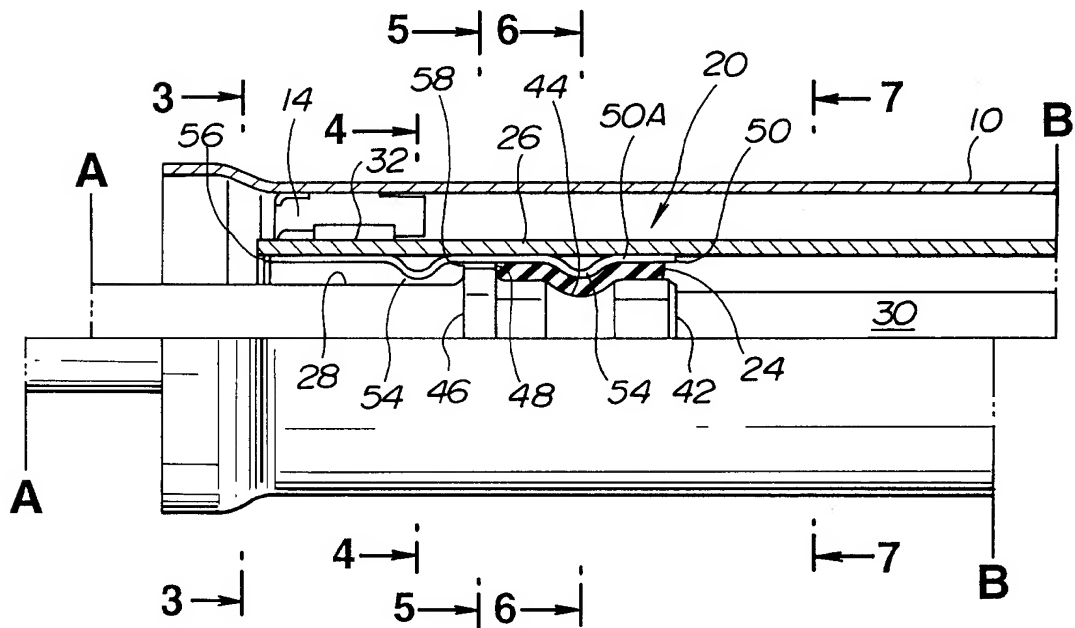
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**FIG.1A**

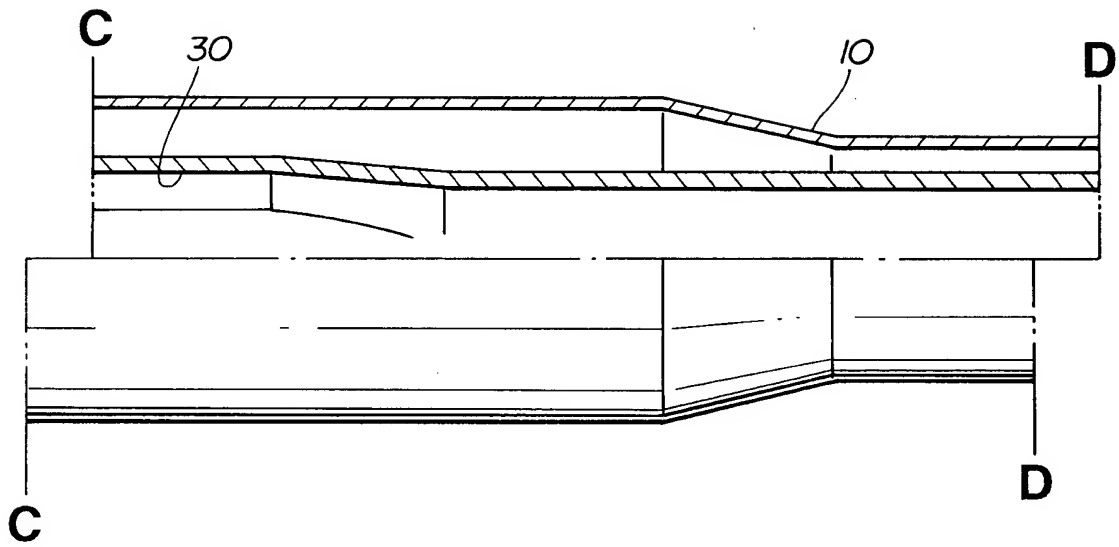


**FIG.1B**

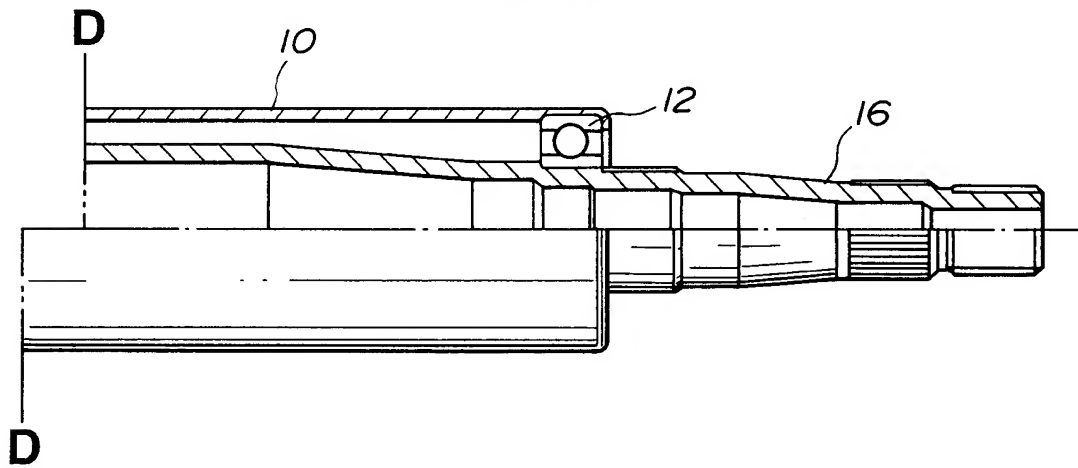




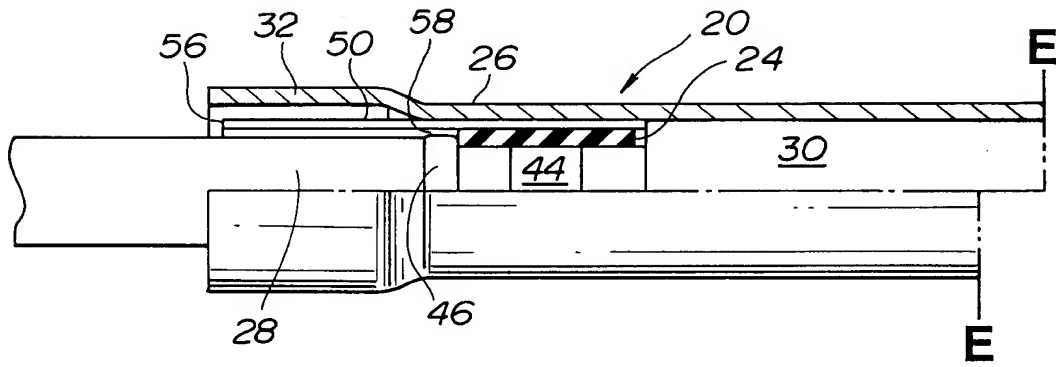
**FIG.1C**



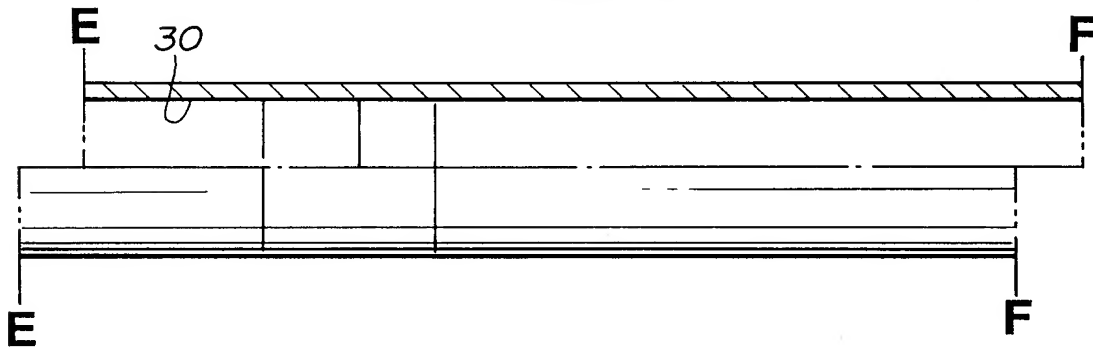
**FIG.1D**



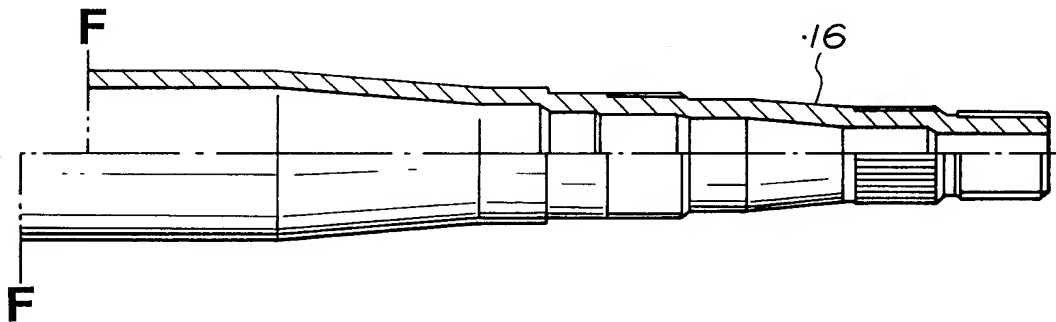
**FIG.2A**



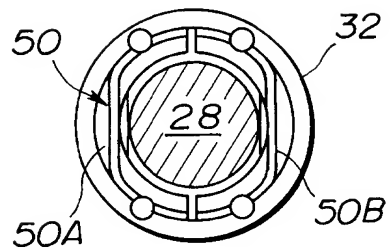
**FIG.2B**



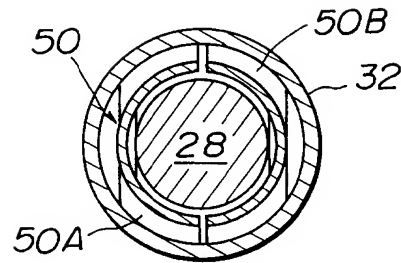
**FIG.2C**



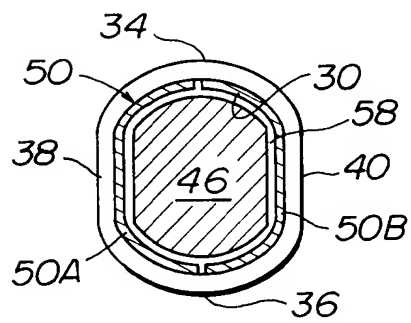
**FIG.3**



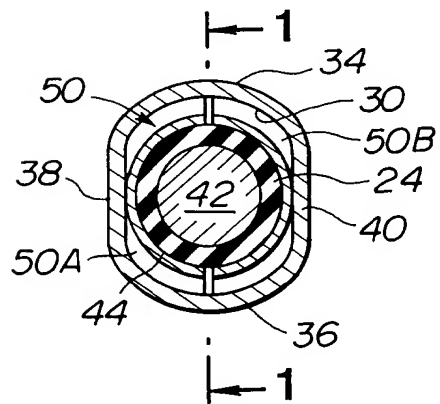
**FIG.4**



**FIG.5**



**FIG.6**



**FIG.7**

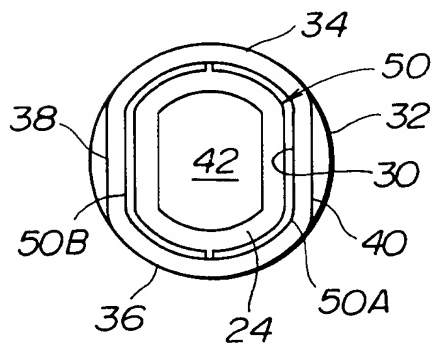


FIG.8

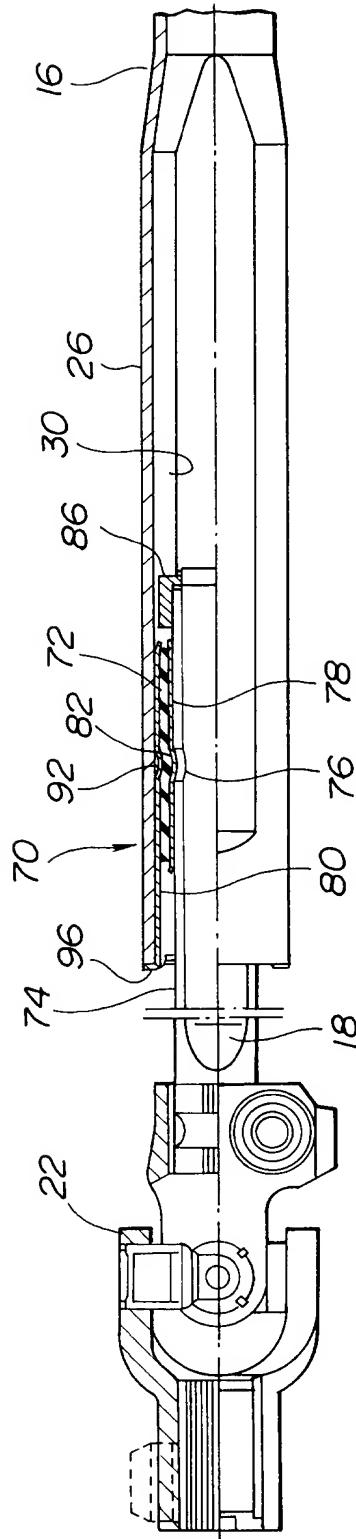


FIG.9

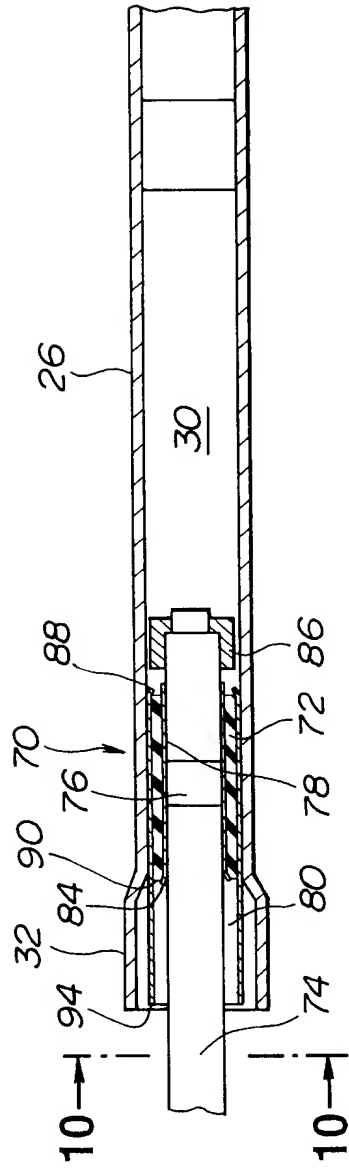
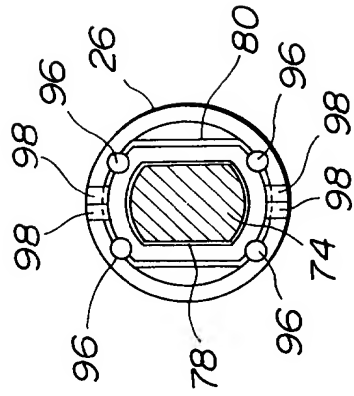
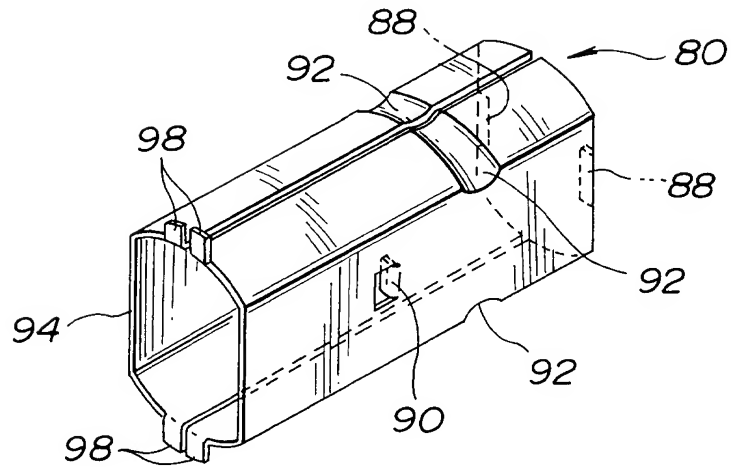


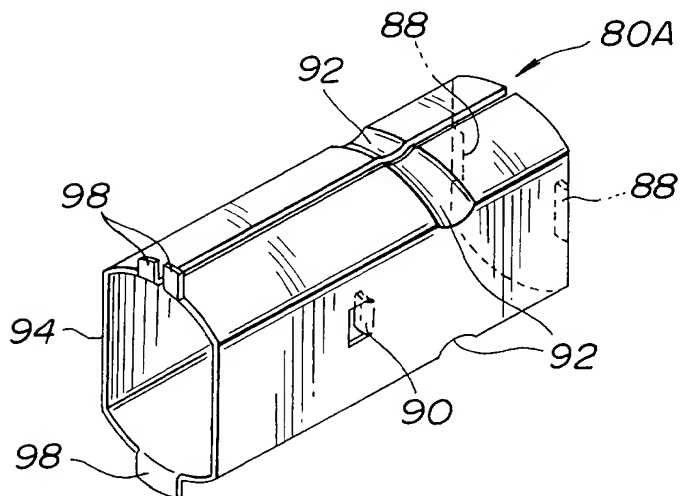
FIG.10



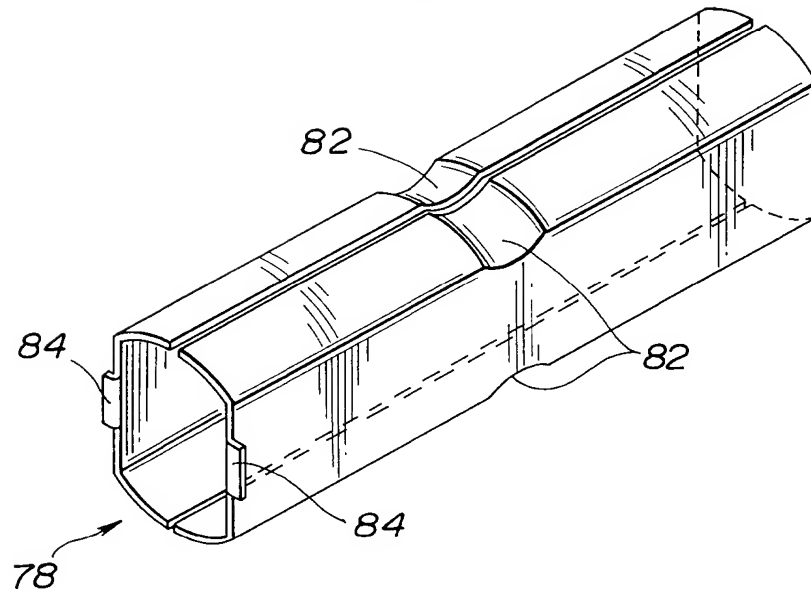
**FIG.11**



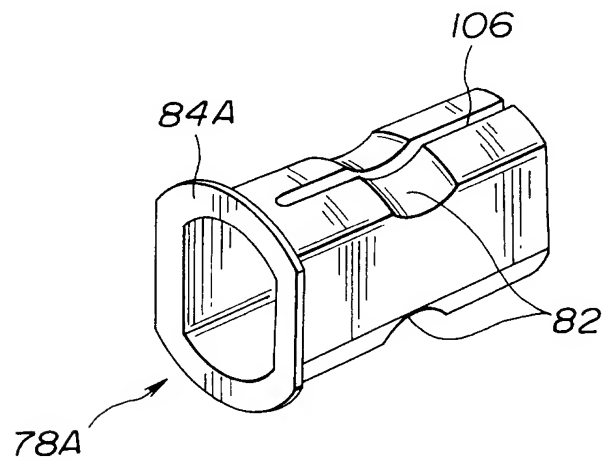
**FIG.12**



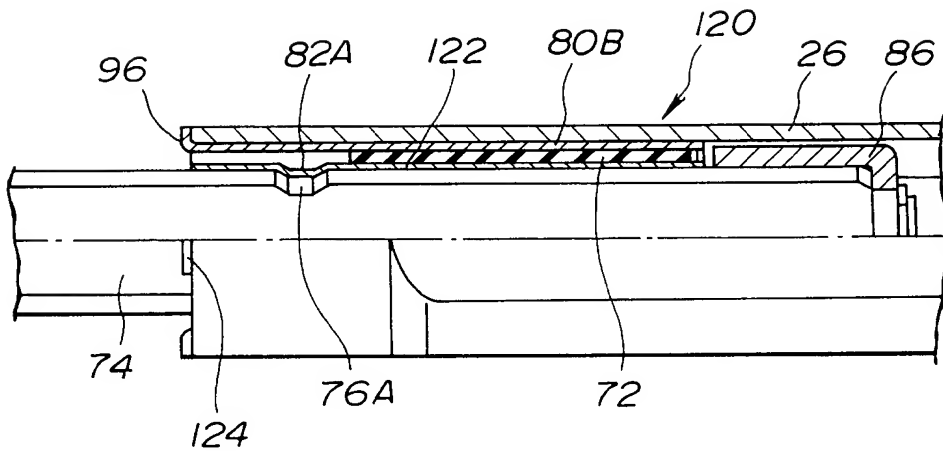
**FIG.13**



**FIG.14**



**FIG.15**



**FIG.16**

